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FRQ Practice 5.1

SUGGESTED SKILL

 *Concept Explanation*

1.B

Explain environmental concepts and processes.

The oceans of the world are often referred to as a commons. **Identify** one other such commons, **explaining** how human activities affect that commons, and **propose a solution** for managing that commons. (3 pts.)

ACCEPTABLE COMMONS: 1 point

- Atmosphere/Air
- Groundwater/Aquifers
- National Forests/National Parks
- Antarctica
- Estuaries
- Great Lakes
- Rivers and Streams
- A variety of other resources may be accepted as a commons **IF** the student clearly demonstrates that it is a public resource being used privately

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FRQ Practice 5.1

SUGGESTED SKILL

 *Concept Explanation*

1.B

Explain environmental concepts and processes.

The oceans of the world are often referred to as a commons. **Identify** one other such commons, **explaining** how human activities affect that commons, and **propose a solution** for managing that commons. (3 pts.)

HUMAN ACTIVITIES: 1 point—must be linked to the chosen commons

- A human activity and brief explanation of how that activity degrades the selected commons can be accepted (e.g., fossil-fuel combustion increases greenhouse gases in the atmosphere).

PRACTICAL MANAGEMENT METHODS: 1 point—must be linked to the chosen commons

- Any specific management suggestion that is practical and linked to the chosen commons can be accepted.

Some answers that may apply to many commons:

- Education of the public—must relate to a specific problem (e.g., teaching about forest fire prevention).
- Regulations, enforcement, agencies—must be directed at a specific problem.

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FRQ Practice 5.2

SUGGESTED SKILL

 *Concept Explanation*

1.A

Describe environmental concepts and processes.

Describe TWO ecosystem services provided for humans by forests.
Explain how clear-cutting would affect each ecosystem service you describe.

4 pts total
(1 per describe
& explain)

Ecosystem Service	Impact of Clear-Cutting
Carbon that is removed from the atmosphere by trees helps to limit the magnitude of the atmospheric greenhouse effect.	<ul style="list-style-type: none">• Some carbon will be released to the atmosphere or will not be removed
Forests provide oxygen (via photosynthesis).	<ul style="list-style-type: none">• Some loss of oxygen, without which we cannot live
Forests provide food products for human consumption (deer, nuts, fungi).	<ul style="list-style-type: none">• Can change available browsing places and sighting of animals due to species composition change, increasing their availability for humans (e.g., deer)
Forests provide habitat for many species, some of which provide food and goods for humans, some of which cause harm.	<ul style="list-style-type: none">• Loss of habitat (biodiversity)
Forests provide wood (e.g., construction material, paper)	<ul style="list-style-type: none">• Increase in the short-term availability of wood, but potential long-term loss of availability
Forests provide wood for fuel.	<ul style="list-style-type: none">• Increase in the short-term availability of wood, but potential long-term loss of availability

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FRQ Practice 5.2

SUGGESTED SKILL

 *Concept Explanation*

1.A

Describe environmental concepts and processes.

Describe TWO ecosystem services provided for humans by forests. **Explain** how clear-cutting would affect each ecosystem service you describe. 4 pts total(1 per describe & explain)

Ecosystem Service	Impact of Clear-Cutting
Forests maintain watershed integrity (e.g., flood control with specific human application).	<ul style="list-style-type: none"> Decreases in watershed integrity
Many products, such as glue, rubber, and medicines, are produced with forest products.	<ul style="list-style-type: none"> Increase in the short-term availability of these products, but potential long-term loss of availability
Forests influence the local microclimate affecting humans (change in temperature, shade, UV, wind breaks).	<ul style="list-style-type: none"> Change in the microclimate
Forests have aesthetic value (hiking, camping, photography, tourism, etc.).	<ul style="list-style-type: none"> Decreases in natural beauty
Forests improve the quality of soil and water used by humans. (Soil and water must be linked to a specific human use.)	<ul style="list-style-type: none"> Increases in erosion and runoff and decreases in groundwater recharge, changing water quality

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FRQ Practice 5.3

Describe one environmental advantage and one environmental disadvantage of using GM crops. (2 pts)

Environmental Advantages: 1 point
(Score only the first advantage provided by student)

Higher yields per acre and hence less acreage needed/impacted by agriculture

Permits low-tillage agriculture (due to herbicide resistance in GM crops), which:

- Reduces soil exposure/erosion
- Reduces energy consumption associated with farm machinery (plowing, harrowing, etc.)
- Can reduce evaporative water loss

GM crops may exhibit:

- Lower fertilizer requirements, which reduces negative impacts of fertilizers
- Insect resistance and the associated reduced impact of insecticide/pesticide use/production/exposure
- Drought resistance and the associated decreased need for irrigation
- Disease resistance and the associated decreased need for fungicide applications
- Salinity tolerance, which decreases the need for flushing of soils with water
- Frost resistance, which extends seasonal productivity and decreases crop loss
- Perennial life span (rather than annual), which reduces the need for tillage (see above)
- Firmer tissues/peels/shells reduce waste as a result of increased shelf life and reduced spoilage

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FRQ Practice 5.3

Describe one environmental advantage and one environmental disadvantage of using GM crops. (2 pts)

Environmental Disadvantages: 1 point
(Score only the first disadvantage provided by student)

Low-tillage agriculture often depends on:

- High dosage/frequent application of herbicides to control competitive weeds that are normally controlled by tillage

GM crops with:

- Insect resistance (e.g., Bt gene) may impact beneficial insects (e.g., pollen toxic to monarch butterflies)
- Drought-resistance gene may lead to agricultural use of currently marginal, semi-arid areas, leading to increased human pressures/loss of natural landscape
- Salinity-tolerance gene may lead to agricultural use of currently marginal, saline soils, leading to increased human pressures/loss of natural landscape
- Altered genes may impact human health with altered proteins and/or subsequent toxins

Native plant diversity may be impacted by the spread of genes to nonengineered crops.

Higher yields per acre often require higher inputs (fertilizer, etc.) and often lead to greater soil depletion and erosion.

GM crops are often engineered to have lower genetic variability than non-GM crops, thereby making GM crop monocultures more vulnerable to mass mortality than non-GM crop monocultures exposed to disease or pest outbreaks or severe environmental changes. (**Note:** To earn this point, the student must clearly contrast GM and non-GM crops and emphasize genetic variability and monoculture agriculture.)

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FRQ Practice 5.4

Explain one disadvantage of using inorganic, commercial fertilizers (1 pt.)

DISADVANTAGES

- Adds no humus or organic matter to soil/decreases water- holding capacity
- Lowers oxygen content of soil and keeps nutrients from being taken up as efficiently
- Does not completely supply all micronutrients
- Requires large amounts of energy for production, transportation, and application
- Releases nitrous oxide (N_2O) a greenhouse gas
- Over-application may harm plant
- Aquatic pollution resulting from runoff in surface or groundwater is detrimental to humans or ecosystems
- Can be very expensive to obtain and apply as compared to unpurchased organic fertilizer (if this is available)

SUGGESTED SKILL

 *Concept Explanation*

1.A

Describe environmental concepts and processes.

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FRQ Practice 5.5

SUGGESTED SKILL

 *Environmental Solutions*

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

Describe how soil salinization occurs. **Propose a solution** to prevent or remediate soil salinization. **Identify** one disadvantage of the solution you propose. (3 pts.)

(i) Describe how salinization occurs.

(1 point)

Any of the following is a correct response:

- Salinization can occur when irrigation water evaporates (or is used by plants), leaving the salts behind in the soils.
- (In arid regions), evaporation of (irrigation) water from the top layer of soil can draw water up from deeper in the soil column (via capillary action). If shallow ground water contains salts (possibly from saltwater encroachment), or if the deeper soil is high in salts, then salts will wick to the surface.
- Precipitation can pick up salts from the soil, pool in areas of poor drainage, and evaporate, leaving behind the salts.
- Misuse of salt-containing fertilizers and/or other soil amendments that contain salts (e.g., lime) may lead to soil salinization.
- Salt applied to roads can run off (or splash/spray) and contaminate roadside soil.
- Tsunamis/storm surges (e.g., from hurricanes) can deposit salts inland.

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FRQ Practice 5.5

SUGGESTED SKILL

 *Environmental Solutions*

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

Describe how soil salinization occurs. **Propose a solution** to prevent or remediate soil salinization. **Identify** one disadvantage of the solution you propose. (3 pts.)

(ii) Describe one method to prevent or remediate soil salinization.

(1 point)

Any of the following is a correct response:

- Irrigate/flush with sufficient (fresh) water to leach the salts down through the soil (especially after the growing season), or wait for rain to flush the salts out of the soil.
- The use of drip irrigation/soaker hoses/etc. requires less water than traditional irrigation, resulting in a lower influx of salt (or less water loss via evaporation).
- Avoid planting crops that require a large amount of water in areas prone to salinization.
- Avoid planting crops until the salt has been flushed from the soil.
- Plant vegetation/crops that remove salt from the soil (e.g., saltbush, barley, oats).
- Improving drainage (e.g., installing drainage tiles) will prevent precipitation/irrigation water from pooling and evaporating.
- Irrigate with water that is low in salt content.
- Use more organic/salt-free fertilizers/avoid using (as much) salt-containing fertilizers and/or other soil amendments that contain salts.
- Incorporate organic material into the soil.
- Use alternatives to road salt (e.g., beet juice, sand)/avoid applying (as much) road salt.
- Plant vegetation/avoid removing vegetation that would protect inland areas from tsunamis/storm surges.

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FRQ Practice 5.5

SUGGESTED SKILL

 *Environmental Solutions*

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

Describe how soil salinization occurs. **Propose a solution** to prevent or remediate soil salinization. **Identify** one disadvantage of the solution you propose. (3 pts.)

iii. Disadvantages (1 pt.) - must be linked to an acceptable remediation/prevention technique from part ii

Irrigate/flush	May cause nearby surface/groundwater depletion or be costly
Drip irrigation	Costly to install/maintain
Avoid high-water crops	May require altering equipment/fertilizer use or may decrease profits
Crops that remove salt	May require altering equipment/fertilizer use or may decrease profits
Irrigate w/low salt H₂O	May require more energy (money) to pump from further source
Drainage tiles	Costly, takes time away from planting (reducing profits)
Add organic material	Costly, takes time away from planting (reducing profits)

FRQ Practice 5.6

Describe ONE economic advantage and one economic disadvantage of using GM crops. (2 pts.)

Economic Advantage: 1 point
(Score only the first advantage provided by student)

For farmers specifically

Permits low/reduced-tillage agriculture resulting in:

- Reduced soil erosion
- Retention of soil nutrients
- Reduced energy consumption associated with farm machinery (plowing, harrowing, spraying, etc.)
- Reduced water loss that lowers associated costs
- Reduced greenhouse gas emissions from agricultural activities and associated costs (carbon sequestration)

Increased profits/reduced costs due to use of GM crops that have:

- Higher yields per acre
- Lower fertilizer/pesticide/herbicide requirements
- Insect resistance, resulting in reduced insecticide cost
- Disease resistance, resulting in reduced fungicide/viral control cost
- Healthier appearance (e.g., reduced viral spotting of skin of papaya)
- Drought resistance, resulting in lower costs for irrigation or expanded land area under cultivation
- Saline resistance, resulting in lower cost for irrigation/mitigation or increased use of marginal lands
- Less worker exposure to fertilizer/pesticides/herbicides and lower associated health-care costs
- Increased nutritional value

- Pharmacological value
- Frost resistance—extends seasonal productivity
- Firm tissue/peels/shells—less spoilage of crops in transit

For society in general

- Decreased health-care costs:
 - Due to reduced worker exposure to pesticides
 - Better-nourished people (“golden rice”)

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FRQ Practice 5.6

Describe ONE economic advantage and one economic disadvantage of using GM crops. (2 pts.)

Economic Disadvantages: 1 point
(Score only the first disadvantage provided by student)

For farmers specifically

Higher yields per acre often lead to greater soil depletion, requiring higher costs of mitigation.

Low-tillage agriculture often depends on:

- Costly high dosage/frequent application of herbicides to control competitive weeds that are normally controlled by tillage

Decreased profits/increased costs due to use of GM crops that:

- Have increased fertilizer demand to reach yield potential
- Require investment in a new generation of pesticides because the GM crop has promoted target insect pest resistance
- Increase the amount and frequency of pesticide applications to mitigate nontarget pests whose virulence increases (when pests targeted by the GM crops are suppressed)
- Have patented seeds (which commit the farmer to annual purchase of seeds that are often too expensive for poor farmers)
- Have sterile seeds, committing the farmer to annual seed purchases
- Risk consumer rejection/import restrictions that result in lower demand for GM crops

For society in general

Costs of/for:

- Tracking and labeling GM crops in the food supply
- Litigation surrounding use of GM crops
- Controlling pest species to which the new gene has been inadvertently transferred
- Unexpected health issues related to GM crops

FRQ Practice 5.7

SUGGESTED SKILL
✂ *Data Analysis*

5.E

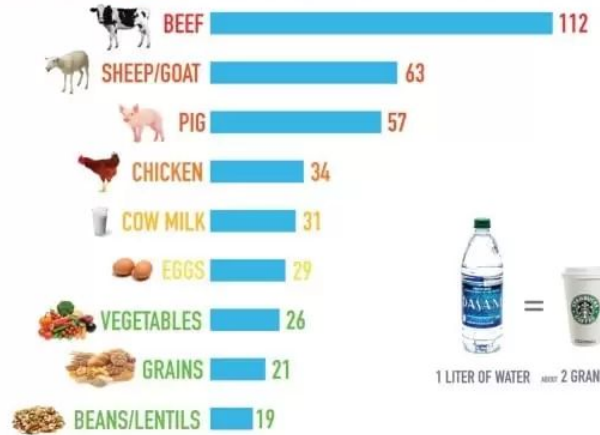
Explain what the data implies or illustrates about environmental issues.

Explain an environmental benefit of eating a plant-based diet, rather than a meat-based diet, using the data below. (1 pt.)

Explain an env. benefit (1 pt.)

- Plant-based diet requires less water, leading to less
 - Aquifer overdraft
 - Surface water depletion
 - FF combustion to power pumps transporting water
 - Soil erosion from irrigation


LITERS OF WATER TO PRODUCE 1 GRAM OF PROTEIN



SOURCE: HOKENSTRA, A.Y. "THE HIDDEN WATER RESOURCE USE BEHIND MEAT AND DAIRY". ANIMAL PROTEINS, AP1

FRQ Practice 5.8

SUGGESTED SKILL

 *Environmental Solutions*

7.B

Describe potential responses or approaches to environmental problems.

Propose a solution to address the issue of fishery depletion.
(1 pt.)

Propose a solution (1 pt.)

- Impose minimum size limits for species that are harvested from the fishery
- Establish an ITQ (Individual Transferable Quota) system to limit the total number of fish harvested from a fishery
- Establish harsher fines or penalties for violating existing fishing quotas/laws
- Establish laws/regulations on how many fish/what weight of fish can be caught per person or per company

FRQ Practice 5.9

SUGGESTED SKILL

 *Environmental Solutions*

7.E

Make a claim that proposes a solution to an environmental problem in an applied context.

An abandoned coal mine site has been found to have very high sulfur levels in the tailings and overburden left at the site. **Describe** one environmental impact of the high sulfur content of the overburden and tailings. **Propose a solution** to remedy or reduce this impact. (2 pts.)

Environmental impacts (1 pt.)

- acidification of the surrounding soil
- acidification of groundwater or adjacent bodies of water
- reduced plant growth/animal distribution
- corrosion of roads/drainage culverts
- increased solubility and transport of heavy metals

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FRQ Practice 5.9

SUGGESTED SKILL

 *Environmental Solutions*

7.E

Make a claim that proposes a solution to an environmental problem in an applied context.

An abandoned coal mine site has been found to have very high sulfur levels in the tailings and overburden left at the site. **Describe** one environmental impact of the high sulfur content of the overburden and tailings. **Propose a solution** to remedy or reduce this impact. (2 pts.)

Propose a solution (1 pt.)


- Buffer/neutralize with alkaline/basic substances such as limestone (calcium carbonate, CaCO_3), sodium hydroxide (NaOH), sodium bicarbonate (NaHCO_3), and anhydrous ammonia (NH_3)
- Cover tailings to reduce contact with precipitation
- Sedimentation ponds/retention basins/catchments
- Bioremediation by sulfate-reducing bacteria

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FRQ Practice 5.10

SUGGESTED SKILL

 Environmental Solutions

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

Describe a possible solution to the issue of urban sprawl. **Identify** one possible economic consequence of this solution (2 pts.)

Describe (1 pt.)

- **Urban growth boundaries could be set to restrict growth outward from city**
- **Mixed land use can enable higher density of business and residential buildings together**
- **Increased walkability/public transit can incentivize people to stay in city, rather than moving out to suburbs**
- **Establishing more green spaces such as parks can incentivize residents to stay**

Identify an economic consequence (1 pt.) - must be related to jobs/income/revenue/etc.

Lost development revenue in suburban areas

Decreased gasoline tax revenue due to less driving

Increase in cost of living in city as demand for housing rises

Increased cost of building additional public transit

Lost business revenue/tax income due to green spaces taking up developable land

Cost to city of installing/building parks and green spaces

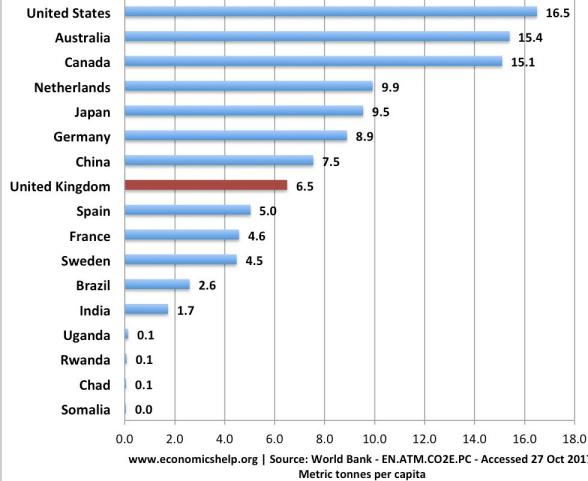
FRQ Practice 5.11

SUGGESTED SKILL
Data Analysis

5.E

Explain what the data implies or illustrates about environmental issues.

CO2 emissions per capita



Describe one factor that accounts for the difference in carbon footprint between the United States and Uganda. **Explain** one environmental consequence of this factor. (2 pts.)

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Describe (1 pt.)

1. Higher standard of living in US leading to more energy use per/person
2. Greater vehicle ownership/travel in US leading to more CO₂ emissions
3. Higher meat consumption resulting in more CO₂ or CH₄ emissions
4. Larger home size, resulting in more energy use/or more materials such as wood or concrete

Explain (1 pt.)

1. Higher energy use requires more habitat destruction to mine the fuel source or resulting in more air pollution (must name specific pollutant ex: PM, SO₂, NO_x)
2. Higher travel requires more gasoline consumption, which results in habitat destruction in areas where oil is extracted or resulting in more air pollution (must name specific pollutant ex: PM, SO₂, NO_x)
3. More meat consumption leads to habitat destruction/soil erosion to grow food for livestock
4. Larger home size = more habitat destruction; to create space for home or harvest materials or urban runoff incr.

FRQ Practice 5.12

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SUGGESTED SKILL

 *Data Analysis*

5.E

Explain what the data implies or illustrates about environmental issues.

Explain which student most likely lives in a highly developed country. **Describe** how one of the four categories of ecological footprint can serve as an environmental indicator. (2 pts.)

Explain (1 pt.)

- **Student 5; highly developed countries have higher per capita (person) ecological footprints due to higher standard of living/greater consumption of raw materials/more energy use**

Describe (1 pt.)

- **Food production; decreasing food production per unit of land can indicate soil degradation**
- **Carbon emissions; increasing carbon emissions can indicate global climate change occurring at a faster rate than ecosystems can adapt**
- **Housing; greater footprint (size) of housing can indicate natural resource consumption (wood/concrete) occurring at unsustainable rates or habitat destruction to create space for increasing home sizes/numbers**
- **Goods and services; greater consumption of goods indicates natural resource use is occurring at a faster rate, which may exceed the rate that natural resources are able to regenerate**

FRQ Practice 5.13

SUGGESTED SKILL

 *Scientific Experiments*

4.B


Identify a research method, design, and/or measure used.

Design an investigation to measure the relationship between the number of trees in a city and amount of stormwater runoff the city produces (4 pts.)

- a) **Propose a hypothesis** for your investigation.
 - b) **Outline a procedure** for your investigation.
 - c) **Identify** your independent variable.
 - d) **Identify** your dependent variable
-
- a) (1 pt.) - **As the number of trees in a city increases, the amount of stormwater runoff decreases or as the number of trees in a city increases, the amount of stormwater runoff increases**
 - b) (1 pt.) - **Procedure must outline at least 3 groups, which specify that runoff will be measured in 3 different cities/areas with 3 different densities/amounts/number of trees**
 - c) (1 pt.) - **tree density/concentration/number/population size**
 - d) (1 pt.) - **amount/volume/measure/rate of urban runoff**

FRQ Practice 5.14

SUGGESTED SKILL

 Environmental Solutions

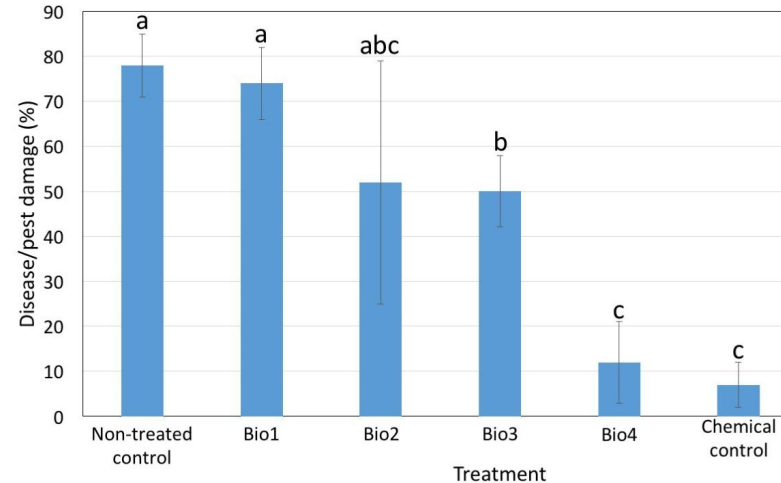
7.D

Use data and evidence to support a potential solution.

Justify whether or not these data support the use of a biocontrol method of limiting pest damage. (1 pt.)

Justify (1 pt.)

- Data do not support use of a biocontrol method as the chemical control method resulted in a lower % of pest damage than any of the biocontrol treatments
- Data do support use of a biocontrol method as 3 of the 4 biocontrol methods significantly reduced pest damage compared to the non-treated control



FRQ Practice 5.15

SUGGESTED SKILL
✂ *Environmental Solutions*

7.E
Make a claim that proposes a solution to an environmental problem in an applied context.

Describe TWO soil conservation strategies that could be used to prevent soil erosion in agricultural fields that are established in this landscape. (2 pts.)


Describe (2 pts.)

- Terracing could be used to create flat beds/planting spaces on this hillside that would catch/retain soil eroded by rain/water
- Trees/shrubs could be planted as windbreaks to reduce erosion due to wind blowing across open landscape
- Contour plowing, parallel to slope could be used to limit soil erosion by water/rain



FRQ Practice 5.16

SUGGESTED SKILL

 *Environmental Solutions*

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

Identify an advantage that aquaculture has over net fishing. **Explain** one environmental consequence of aquaculture. (2 pts.)

Identify (1 pt.)

- Eliminates bycatch/unintended species caught in nets
- Eliminates coral reef damage by nets
- Reduces water turbidity due to sediment disruption by nets
- Reduces fuel required by fishing boats

Explain (1 pt.)

- High concentration of fish waste in one location leading to
 - Eutrophication from excess nitrogen/phosphorus
 - Decreased light penetration and photosynthesis by producers beneath surface
 - Water contamination due to pathogens/hormones/antibiotics in waste
- Deforestation/removal of mangrove swamps to make room for aquaculture

FRQ Practice 5.17


Identify TWO characteristics of a forest that develop when fires are suppressed, and **explain** how prescribed burns could address each of these characteristics. (3 pts.)

Identify (2 pts.)

Characteristics of Forests

- Accumulation of combustible materials (layer of leaf litter and debris on forest floor, dead trees, etc.)
- Increase in understory growth (grasses, shrubs, brush, ladder trees)
- Larger trees develop
- Even-aged stands develop
- Tree density increases
- Fire-intolerant species increase in number in the understory
- Fire-tolerant species that need fire to germinate seeds decrease in population
- Increased canopy coverage eliminates understory growth
- Increase or decrease in the rate of nutrient cycling (e.g., release of nutrients of litter, lack of nutrient-rich ash)
- No loss of nutrients to burning in intense fires
- Increased susceptibility to disease/parasites

SUGGESTED SKILL

 *Environmental Solutions*

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

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FRQ Practice 5.17

Identify TWO characteristics of a forest that develop when fires are suppressed, and **explain** how prescribed burns could address each of these characteristics. (3 pts.)

Explain (1 pt.)

Explanations for Increased Fire Risk


Adds to fuel load [intensity]

- Increased leaf litter
- Increased density of large trees
- Increased size of trees
- Increase in brush and small trees
- Species composition change

Adds to spreading of fire [extent]

- Increased density of trees
- Increased density of understory growth
- Ladder trees leading to crown fires

SUGGESTED SKILL

 *Environmental Solutions*

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

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